Dioxin-Like Polychlorinated Biphenyls at Dilijan Landfills (Republic of Armenia)

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Abstract
Polychlorinated biphenyls (PCBs) are substances of wide distribution, high toxicity, persistence, and ability to long-distance migration. They are characterized by unique properties: temperature stability; high boiling point; non-combustibility; resistance to chemical and physical influences; high dielectric constants.
The presence and concentration of dioxin-like and non-dioxin-like PCBs in old and new landfills of Dilijan district (Republic of Armenia) were investigated. Municipal waste dumps of Dilijan are active sources of PCBs accumulation and spread. In soil samples from both the old and new landfills excess concentrations of PCBs were found in 100% of cases compared to normative level, and the summary concentrations of the latter multiply exceeded the normative level.
PCBs-related environmental pollution is of great concern because the emergence and spread of PCBs in nature is not always subject to control and regulation, as the sources of PCBs formation are diverse.
Keywords: PCBs, POPs, environmental pollution, landfills.

1. Introduction

Polychlorinated biphenyls (PCBs) are known for wide distribution, high toxicity, persistence, and ability to long-distance migration are characterized by unique properties: temperature stability; high boiling point; non-combustibility; resistance to chemical and physical influences; high dielectric constants. Such features allow PCBs versatile application as heat transfer fluids in heat exchangers, dielectrics in transformers and capacitors, fluids for hydraulic systems, plasticizers in lacquers, plastic masses, printing inks, copy paper, lubricants, insulating materials for cables and wires, fungicides for protection of building structures and wood, fillers for pesticides, additives to household chemicals, substitutes for wax, resins and rubber for impregnating fabrics. Sources of PCBs generation and spread in the environment are diverse, as they are used not only in energy sector.

2. Material and Methods

The presence and concentration of dioxin-like and non-dioxin-like PCBs in old and new landfills of Dilijan district (Republic of Armenia) were investigated. At the landfills wastes were disposed without prior separation,. Sampling was done at both the old and new landfills and 20 samples of soil were taken for further laboratory analyses. Determination was done on Shimadzu chromatograph equipped with an electron capture detector. Separation of substances was performed on a 60 m glass capillary column with DB-5MS UI.

3. Results and Discussion

The results of analyses (n=560) were focused on concentrations of dioxin-like PCBs; non-dioxin-like PCBs; and common PCBs. Samples numbered from 1 to 9 (NN 1-9) were taken from the old landfill functioning since 1997, while samples from number 10 to 20 (NN 10-20) were collected from the new landfill that is in operation since 2016. Tables 1 and 2 present the obtained results in our current study for dioxin-like PCBs, as well as data on non-dioxin-like PCBs [Aleksandryan et al., 2019a].

For comparison soil samples were taken from Nubarashen landfill and analyzed for determination of 14 dioxin-like PCBs [Aleksandryan et al., 2018]. Sampling was also done at North-Western part of functioning Ararat dumpsite and adjacent area. Samples were taken in a semicircle from the area between the dump and nearby plain [Aleksandryan et al., 2019b]. As to dioxin-like polychlorinated biphenyls, PCBs 77, 81, 105, 114, 118, 123 were mainly found in Ararat dumpsite, while insignificant quantities of PCB-169 were identified very rarely. Attention was drawn to PCB-81, because the 2- or 3-fold excess of PCB total concentrations was due to this PCB isomer. Particular attention was drawn to the sum of all concentrations of studied POPs. Their large number gave reason to consider Ararat dumpsite an independent source of POPs.

Obvious processes of open waste burning at the dump as a means of its destruction lead to formation of not only PCBs and dioxins, but to other chlorinated derivatives as well. Only this can explain the presence of high concentrations of α-HCH exceeding the standard 57 times.

4. Conclusion

Based on our findings, we can conclude that:

- Dumps of municipal waste in Dilijan, both the old and new sites, are active sources of PCBs accumulation and spread. In soil samples from both landfills excess concentrations of PCBs were found in 100% of cases compared to normative level, and the summary concentrations of the latter multiply exceeded the normative;
- There was no correlation between data obtained at the old and new sites, as samples were taken from 2 different landfills with different surface area, operation period, and amounts of disposed wastes. As to data correlation with PCB fate, the old landfill is almost closed, non-functioning, no wastes are currently disposed and there is no open burning. At the new landfill, under open low-temperature burning and smouldering of waste, PCBs are generated as Dioxins/ Furans precursors.
- The problems of PCBs-related environmental pollution are of great concern because the emergence and spread of PCBs in nature is not always subject to control and regulation, as the sources of PCBs formation are diverse. POPs continue to be one of the most important environmental pollutants. If we consider such an integral indicator as average total concentration of studied POPs, then in the "best" case hygienic standards were exceeded from 60 to 13 times, i.e. dumps represent a peculiar source for POPs spread.
- As a possible origin of PCBs at the landfills the open low-temperature burning and subsequent smouldering of waste technical oils, hydraulic fluids, insulation means, lacquers, dies/paints, , used transformers, etc.

Table 1. . Summary concentrations of PCBs in soil samples collected at Dilijan old urban landfill.

Samples, NN	1	2	3	4	5	6	7	8	9
Summary concentration of dioxin-like PCBs, mcg/kg	31.13	28.47	49.00	35.36	39.41	6.10	9.83	43.48	9.61
Summary concentration of non-dioxin-like PCBs, mcg/kg	532.18	725.54	491.86	257.64	522.50	182.010	228.07	260.88	211.41

Table 2. . Summary concentrations of PCBs in soil samples collected at Dilijan new urban landfill

Samples, NN	10	11	12	13	14	15	16	17	18	19	20
Concentration of dioxin-like PCBs, mcg/kg	152.78	41.65	21.05	40.76	27.88	16.57	35.54	77.75	5.61	3.09	94.53
Concentration of non-dioxin-like PCBs, mcg/kg	579.64	300.72	301.44	584.09	414.14	384.48	259.04	377.61	332.80	162.95	352.12

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